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CONTEXTUAL CONTROL BY FUNCTION AND FORM OF TRANSFER OF FUNCTIONS

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This study investigated conditions leading to contextual control by stimulus topography over transfer of functions. Three 4-member stimulus equivalence classes, each consisting of four (A, B, C, D) topographically distinct visual stimuli, were established for 5 college students. Across classes, designated A stimuli were open-ended linear figures, B stimuli were circular, C stimuli three-sided, and D stimuli four-sided. Three different computer tasks then were trained with the B stimuli. Differential reinforcement and punishment procedures were then used to establish control over function transfer by the topography of the class members. For Task 1, function transfer, responding to C and D stimuli as subjects had to B stimuli, was reinforced. For Task 2, function transfer was reinforced for C stimuli but punished for D stimuli. For Task 3, function transfer was punished for both C and D stimuli. New equivalence classes were then established and tests for generalized contextual control were presented. All 5 subjects showed generalized contextual control of transfer of functions by stimulus topography. Implications of contextual control over function transfer in natural settings are discussed.

Key words: stimulus equivalence, transformation of function, transfer of function, contextual control, stimulus topography, button press, humans

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Much of the interesting data gathered from research on stimulus equivalence and derived relational responding has been on the transfer or transformation of stimulus functions. These terms refer to the untrained acquisition of stimulus functions that occurs after an equivalence class or relational frame is established and a novel function subsequently is trained for some elements of that class or frame (see Dougher & Markham, 1996; Dymond & Rehfeldt, 2000; Hayes, 1991; Hayes & Barnes, 1997; Sidman, 1994 for further discussion). The term transfer of function tends to be used when the untrained function acquisition is based on stimulus equivalence, and transformation is most often used when it is based on relations other than equivalence (Dymond & Rehfeldt, 2000). In the present study, we use the term transfer of function to emphasize that the untrained function acquisition is based on stimulus equivalence.

Transfer of function with a wide variety of stimulus functions has been reported in the literature, including ordinal stimulus control (Green, Sigurdardottir, & Saunders, 1991; Wulfert & Hayes, 1988), conditional stimulus control (Wulfert & Hayes, 1988), simple discriminative control (de Rose, McIlvane, Dube, Galpin, & Stoddard, 1988), conditioned reinforcement and punishment (Greenway, Dougher, & Wulfert, 1996; Hayes, Kohlenberg, & Hayes, 1991), and respondent elicitation (Dougher, Augustson, Markham, Greenway, & Wulfert, 1994; Roche & Barnes, 1997). Although transfer of function is robust, it is obvious that the members of equivalence classes do not and perhaps cannot share all functions. As Sidman (1992) has pointed out, "'Route 128' on the map, and the road on which we are driving are equivalent when we are trying to find our way to an unfamiliar place, but we do not try to drive our car onto the words, or to illuminate the road with a reading light. We do not try to eat the word, 'bread,' or to swat the word, 'fly.'" (p. 22). Obviously, some contextual control exists that limits the transfer of functions within existing equivalence classes. Interestingly, however, although contextual control over the transfer of functions is widely assumed to occur (Hayes, 1991; Hayes & Hayes, 1992; Sidman, 1994), only a small number of empirical studies have addressed this issue directly.

Wulfert and Hayes (1988) used computer-presented higher-order conditional discrimination (arbitrary match-to-sample) procedures with college students to establish contextual control by background colors of the computer

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screen over equivalence class membership. Subsequent tests for function transfer were conducted in the different background colors, and the results clearly showed that transfer of function occurred only within the classes controlled by the respective colors. Although these findings are relevant to the issue of contextual control over transfer of function, it was class membership rather than function transfer per se that was brought under contextual control in that study. It did not demonstrate contextual control over transfer of function within established equivalence classes.

Using college students as subjects, Dougher, Perkins, Greenway, Koons, and Chiasson (2002) established three 5-member equivalence classes (A1, B1, C1, D1, E1; A2, B2, C2, D2, E2; A3, B3, C3, D3, E3). The subjects then were trained to select a specific letter from the computer keyboard in the presence of each of the B stimuli from the three classes. For example, pressing 'V' was correct in the presence of B1, pressing 'M' was correct in the presence of B2, and pressing 'S' was correct in the presence of B3. Procedures then were implemented that were intended to bring the transfer of function within the three equivalence classes under contextual control of the background color of the computer screen. Specifically, when the background color was red, responding in line with function transfer (i.e., responding to the C stimuli as subjects had responded to the respective B stimuli) was reinforced. When the background was blue, responding in accord with the transfer of functions was punished. That is, responding to the C stimuli as had been trained with the corresponding B stimuli was punished, and any other response was reinforced. This training resulted in generalized contextual control by the background colors over transfer of function as evidenced in two ways: 1) The background colors differentially controlled how subjects responded to other members of the equivalence classes (the D and E stimuli) after novel letter-choice tasks were trained with the B stimuli; and 2) The control exerted by the background colors extended to the transfer of functions within novel equivalence classes for most subjects.

Although the Dougher et al. (2002) study demonstrated contextual control over function transfer within equivalence classes, the stimuli that exerted control (i.e., background colors) were external to the equivalence classes. In natural settings, however, a number of contextual factors exert control over function transfer, including the formal or topographical features of the respective members of stimulus classes. To continue with Sidman's (1992) example, a loaf of bread and the word *bread* are topographically different, and these formally distinct stimuli evoke both common and distinct classes of behavior. Both, for example, may evoke the verbal utterance ''bread,'' elicit salivation, or prompt a consideration of the dietary consequences of eating bread. As Sidman notes, however, we do not eat the word *bread*, and we typically do not try to read an actual slice of bread.

The processes by which the topographical features of members of an equivalence class acquire differential stimulus control have not been determined, but it is not unreasonable to assume that they involve differential reinforcement and instruction. Although eating cake is often reinforcing, eating pictures of cakes is not, even for young children, and it is common to hear parents instructing children about which things are and are not appropriate to put in their mouths. The consequences for swatting a fly differ substantially from those for swatting the printed word *fly*. These differential consequences establish discriminative control over responding so that words and pictures typically do not evoke the full range of responses that are evoked by the stimuli the words represent. As a result, we may have certain verbal, perceptual, and visceral responses to the word *fly*, but we typically don't swat it.

Once the relations between topographically distinct stimuli and their appropriate response classes are established, the control exerted by the relevant stimulus features likely generalize beyond specific stimuli to other, physically similar stimuli. For instance, after a punishing or nonreinforcing experience of eating the picture of a cake, the future consumption of any picture is likely to be reduced. As this pertains to the transfer of functions, the topographical features of the members of an equivalence class would then influence the transfer of their functions or, more specifically, the particular behaviors they evoke. As an example, once we learn that the Spanish word for *fly* is *mosca*, the Spanish word typically acquires the functions of its English equivalent, but not all of the functions of actual flies (or moscas). That is, we don't swat the word *mosca* any more than we would swat the word *fly*.

Studies with children have underscored the need to understand the factors that control function transfer. DeLoache (2004) demonstrated that when 9-month-olds are presented with realistic pictures of objects, they behave toward the pictures as if they were the actual objects. For example, when presented with a realistic photograph of a baby bottle, one 9-month-old infant attempted to put his lips on the nipple on the picture of the bottle. By 18 months these examples of poor stimulus control typically disappear. Other studies demonstrated how children in the 18–30 month age range committed ''scale errors'', that is, treating small replicas of objects as if they were the regular size, such as trying to sit on tiny chairs or climbing into small toy cars (DeLoache, Uttal, & Rosengren, 2004). Although these errors are correctly seen as examples of inappropriate primary stimulus generalization or a lack of discriminative control, they are somewhat analogous to the examples presented earlier in this paper, with the major difference being that the previous examples involve inappropriate secondary generalization or function transfer. The relationship of experience with objects and a child's ability to demonstrate appropriate function transfer remains a topic in need for further clarification (DeLoache, Pierroutsakos, & Uttal, 2003). Much of the developmental literature has focused on cognitive models of representation and concept formation, but attention to environment–behavior relations and differential reinforcement histories may prove to be an important factor in the understanding of these behavioral errors.

Although it seems clear that the topographical features of members of equivalence classes do exert contextual control over transfer of function, it has not yet been empirically demonstrated. Nor has it been demonstrated that differential reinforcement and generalization could play a role in this process. The present study is an analogue experiment, the purpose of which is to determine whether differential reinforcement and punishment procedures could produce contextual control by the topographical features of equivalence class members over transfer of functions.

A simple, straightforward demonstration of this effect would require at least two 3-member equivalence classes, each composed of three different stimulus forms. For example, both classes might consist of one circular shaped (A), one triangular shaped (B), and one rectangular shaped (C) stimulus. Differential reinforcement procedures would then be used to establish contextual control over transfer of function by the different forms. Following the establishment of these classes, subjects would be trained to perform two topographically distinct behaviors or tasks in the presence of each of the two triangular shapes (B1 and B2). As an example, one task might require subjects to select a specific letter from a row on a computer keyboard, and the other might require them to select among an array of colored boxes presented on the computer screen. The specific letters and colored boxes associated with reinforcement in the two tasks would be different in the presence of B1 and B2. For example selections of the letter *d* and a blue box in the presence of B1 would be reinforced, whereas selections of the letter *l* and a red box would be reinforced in the presence of B2. Once subjects reach criterion on these tasks, contingencies would be arranged so that transfer of function on the letter-choice task would be reinforced, but it would be punished on the colored-box task. Specifically, selecting the same letter in the presence of C1 as subjects had in the presence of B1 would be reinforced, but selecting the same colored box in the presence of C1 as subjects had in the presence of B1 would be punished. These procedures would be repeated with new letters and colored boxes until function transfer is brought under differential stimulus control of the shape (triangular or rectangular) of the presented stimulus. At that point, novel equivalence classes would be trained with new circular, triangular, and rectangular shaped elements, and new letter-choice and colored-box selection tasks would be trained in the presence of B1 and B2. Then, C1 and C2 would be presented to test for the generalized control by shape over function transfer.

To illustrate how these procedures might map onto Sidman's (1992) example with words and the actual stimuli or events they stand for, consider the following, simplified scenario. A child learns in the presence of actual flies to both name and swat flies. Then, in the presence of the written word *fly*, the child learns to name it but not to swat it. In addition, in the presence of actual moths, the child learns to both name and swat moths and later learns to name but not swat the word *moth*. Through this process, the words *fly* and *moth* come to evoke only one of the two overt behaviors evoked by flies and moths. With repeated differential learning experiences of this type, children learn not to emit certain behaviors in the presence of written words. A limited range of functions transfer when written stimuli enter into equivalence classes. Some time later the child learns to both name and swat spiders, but upon seeing the word *spider*, she refrains from swatting it. In this highly simplified but illustrative example, the trained contextual control over transfer of function by specific textual stimuli has generalized to the word *spider*.

In the present study, we elaborated upon this basic demonstration. Instead of two 3-member classes, we established three 4-member classes and trained three distinct behavioral tasks to each of the B stimuli. Each class consisted of four distinct forms: open-ended linear (A), curvilinear (B), three-sided (C), and four-sided (D). Differential reinforcement and punishment procedures were used to establish control over function transfer by the topography of the class members. For Task 1, function transfer, responding to the C and D stimuli as subjects had to the B stimuli, was reinforced. For Task 2, transfer of function was reinforced for the C stimuli but punished for the D stimuli. For Task 3, transfer of function was punished for both the C and D stimuli. Once control over function transfer by the form of the class members was established, three new four-member equivalence classes were established. Then, different forms of the three tasks were trained with the B stimuli, and tests were implemented to assess whether the form of the class members had acquired generalized contextual control over transfer of function.

As already mentioned, the present study differs from Dougher et al. (2002) in that the focus of the present study was on establishing contextual control by the topographical features of the members of the equivalence classes rather than by features of external contextual stimuli. Another difference between the two studies is that subjects in the Dougher et al. study were required to emit some response even in the background color (blue) in which function transfer was punished. In the present study, subjects were allowed to refrain from responding or to not emit any experimenter-defined responses in situations where behaving in accord with function transfer was punished. We thought this was more analogous to natural settings where alternative responses are not required in contexts where transfer of function is not reinforced.

METHOD

Subjects

Six male and 8 female undergraduates from the University of New Mexico were recruited as subjects. Eleven were recruited from introductory psychology classes, and they received course credit for up to 4 hr of participation and monetary compensation at the rate of $5.00 per hr for additional time. Three other subjects, also unfamiliar with the concept of stimulus equivalence, were recruited from higher-level psychology classes. All of their participation was compensated at $5.00 per hr. The initial experimental session lasted 4 to 6 hr. Succeeding sessions lasted 2 to 4 hr. Nine subjects either terminated their participation after the first session or failed to show for follow-up sessions. In the end, 3 male and 2 female subjects completed the experiment. Total participation time for these 5 subjects ranged from 9 to 13 hr. All subjects read and signed a statement of informed consent before beginning the experiment, and all were fully debriefed at the end.

Setting, Apparatus, and Stimuli

The experiment was conducted in a 2 m by 2 m experimental room equipped with a table, chair, a two-way mirror for subject observation, and a personal computer with a standard keyboard and 25 cm color monitor. The computer presented stimuli and recorded responses. There were four types of stimuli: linear, circular, three-sided, and four-sided. All stimuli were white and presented on a black background. A total of four sets of stimuli were

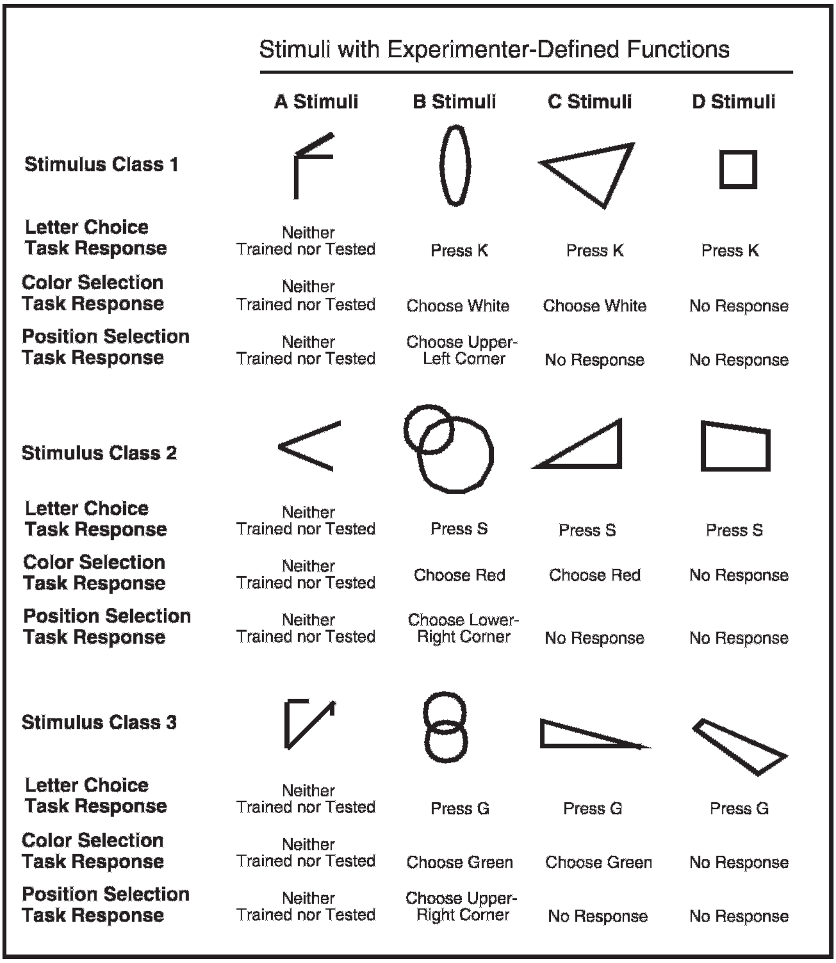

Fig. 1. Examples of stimuli and experimenter-defined functions.

available for use in the study. An example of one set of 12 stimuli used in the study is shown in Figure 1.

Procedure

General procedure. The general strategy in the study was to: 1) train and test three 4-member equivalence classes; 2) train a specific discriminative function for each of the B stimuli using a letter-choice (LC) task, then present the C (3-sided) and D (4-sided) stimuli and differentially reinforce function transfer in the presence of both; 3) train another discriminative function for each of the B stimuli using a color-selection (CS) task, then present the C and D stimuli and differentially reinforce function transfer in the presence of the C stimuli and differentially punish it in the presence of the D stimuli; 4) train new LC and CS tasks with the B stimuli and test for control by stimulus topography over transfer of function. If the test criterion is not met, retrain with the C and D stimuli and repeat the test; 5) train another discriminative function for the B stimuli using a position-selection (PS) task, then present the C and D stimuli and differentially punish function transfer in the presence of both; 6) train new LC, CS, and PS tasks with the B stimuli and test for control by stimulus topography of the C and D stimuli over transfer of function; if test criterion is not met, retrain with C and D stimuli and repeat the test; 7) establish three new four-member equivalence classes with novel stimuli, train new LC, CS, and PS tasks with the B stimuli, and then present C and D stimuli to test for generalized control by stimulus topography over function transfer. If test criterion is not met, repeat with new LC, CS, and PS tasks; repeat Step 7 with new stimuli and new tasks a maximum of two times; if criterion is met, then test for equivalence with the most recently trained stimulus set. A basic example of one possible permutation of specific responses required for a stimulus set is provided in Figure 1.

There were some aspects of the procedure that were common to all steps in the experiment. All subjects were run individually. All instructions were typed and subjects were asked to read them. They were then asked to explain the instructions to the experimenter. If subjects' explanation indicated misunderstanding, they were required to reread the instructions and explain them once again. This continued until the subject's oral responses corresponded to the written instructions. All training and testing trials were quasirandomized within trial blocks. Within each trial block, each stimulus with the same alpha designation occurred equally often and, where appropriate, in random serial position. In all tasks, a response immediately cleared the screen. During training trials, each response was followed by the written word ''Correct'' or ''Wrong'' for 1.5 s. The screen then cleared again for an intertrial interval of 1 s. On test trials, no written feedback was provided, but responses were followed by a 2-s intertrial interval. On training trials allowing for a ''no response'' option, a period of 5 s without a response produced the appropriate written feedback and the intertrial interval described above. Thus, not responding when an active response was required would be followed by ''Wrong'' after 5 s. Responses occurring during feedback or the intertrial interval were not recorded. The performance criterion required to move on to the next step of the experiment was always 94% (or as close to that as the number of trials allowed) over a designated number of trial blocks. With the exception of those steps that required new instructions, there was no indication provided to subjects that they had completed any of the steps of the experiment. If subjects took a break or terminated a session, they began at the start of that part of the experiment upon their return. If subjects terminated a session after successfully completing a part of the experiment, they were presented with the next scheduled phase of the experiment upon return.

Step 1: Establishing three 4-member equivalence classes. In order to establish three 4-member (A1, B1, C1, D1; A2, B2, C2, D2; A3, B3, C3, D3) equivalence classes, nine interrelated conditional relations were trained using one-to-many match-to-sample procedures (Spradlin & Saunders, 1986). Each of the three classes contained one linear shape (A), one circular shape (B), one three-sided shape (C), and one four-sided shape (D). Alphanumeric designations of the stimuli are intended to facilitate description of the procedure and were never available to the subjects. Numbers refer to class membership and letters refer to the specific members of each class. Within each stimulus type, the figures were randomly assigned to the three different stimulus equivalence classes for each subject. At the beginning of Step 1, the following instructions were presented to the subjects:

> When the experiment begins, symbols will appear on the computer screen. One symbol will appear at the upper-middle of the screen and three additional symbols will appear at the lower left, middle, and right of the screen. Your task is to choose the correct symbol from among those in the lower portion of the screen. In this task you will choose just one symbol on each trial. To do this, press the number ''1'', ''2'', or ''3'' on the keyboard number pad located on the right hand portion of the keyboard. Pressing these numbers will select the lower left, middle, or right symbol, respectively. During the first part of the experiment, you will be given feedback after your selections. As the experiment progresses, you won't receive feedback. However, there is always a correct answer. Please try to do your best. Do you have any questions?

On each trial, a sample stimulus appeared at the top center of the monitor. After a 1 s delay, the sample stimulus remained on the screen while three comparison stimuli appeared at the bottom left, middle, and right of the screen. Subjects selected a comparison stimulus by pressing the 1 (left), 2 (middle), or 3 (right) key on the keyboard. In both testing and training, comparison arrays consisted of stimuli with the same alpha designation, e.g., C1, C2, C3. Each sample and comparison array comprised a trial type. Training trials were presented in blocks of nine trial types, one for each of the nine trained relations. Training continued until subjects reached criterion (94%) over six consecutive trial blocks (i.e., 51 correct responses over 54 consecutive trials).

Once the training criterion was reached, tests for the nine symmetry and 18 equivalence relations were introduced without feedback. Because one-to-many training procedures were used, there were no tests for transitivity that did not also involve symmetry. Accordingly, all tests other than those for symmetry were called equivalence tests. Test trials were presented in blocks of 54 trials with two test trials of each symmetry and equivalence relation randomly presented in each block. Up to two blocks of test trials were presented, and subjects were required to meet criterion in one block before moving on to Step 2. If criterion was not met by the end of the second trial block, subjects returned to another round of training and testing until the testing criterion was met.

Step 2: Training the letter-choice (LC) task with the B stimuli and testing and training transfer of function on the LC task with the C and D stimuli. The B stimuli were used to train the subjects in a LC task. At the beginning of Step 2, the following instructions were presented:

> During this part of the experiment, you will be performing tasks using one line of keys on the keypad at a time. First, you will be using the bottom line of keys on the keyboard line (ZXCVBNM,./ with the CAPS LOCK on). Choose the correct key from the keypad, or do not respond. It is possible that not responding is the correct response. If you go five seconds without responding, your answer will be recorded as ''no response.'' After a trial is over, at times you will receive feedback. At other times, you will not receive feedback, but there is always a correct response (or a correct ''no response''). After you are done with the first line of the keyboard, you will use the second line of keys (ASDFGHJKL; with CAPS LOCK on), and choose the correct key from the keypad. An additional task would involve the third line of letters on the keyboard (QWERTYUIOP with CAPS LOCK on). The fourth task would involve the top line on the keyboard (1234567890). A fifth task would use the bottom line of keys, and succeeding tasks of this type will follow the same pattern: second line, third line, fourth line, first line, second line, and so on. Please contact the experimenter when you are finished, or if you need to take a break. Do you have any questions?

For the LC training, a randomly selected B stimulus was presented in the center of the computer screen. Subjects could either select a letter from the bottom line of the keyboard or choose not to respond. If subjects did not respond within 5 s following the presentation of the stimulus, a ''no response'' was recorded. An experimenter-defined ''correct'' letter was randomly assigned to each of the three B stimuli without replacement for every LC task that was trained. Training trials were presented in blocks of the three trial types, one for each of the B stimuli. Correct letter selections for B stimuli varied across subjects and permutations of the LC task. Training continued until subjects reached criterion over six consecutive trial blocks (i.e., 17 correct responses over 18 consecutive trials) before moving on to the next step.

Based on our experience in previous studies, subjects frequently show evidence of transfer of functions unless specifically trained otherwise. For example, if subjects were trained to select 'N' in the presence of B1, they could be expected to select 'N' in the presence of C1 and D1 also. To assess this expectation, subjects were presented with a block of nine test trials composed of the three previously trained B trials and one trial with each of the three C and three D stimuli. In order to move on to Step 3 with no additional training, subjects were required to meet the test criterion over two consecutive trial blocks. Subjects who did not meet criterion after six consecutive test trial blocks (54 trials) were presented with these same trial blocks with feedback until criterion was reached over two consecutive training blocks. This constituted direct training of function transfer with the C and D stimuli on the LC task. Once training criterion was reached, two blocks of test trials were presented without feedback. If the test criterion was not met, iterations of retraining and retesting occurred until it was. Subjects who did not meet criterion on the first set of BCD test trials on a new LC task repeated Step 2 with a new LC task (i.e., new letters were assigned to the B stimuli) until they did so.

Step 3: Training the color-selection (CS) task with the B stimuli, and training and testing differential transfer of function on the CS task with the C and

D stimuli. The B stimuli were then used to train the subjects in a CS task. At the beginning of Step 2, the following instructions were presented:

> For this task, there will be a single stimulus at the top of the screen, and three different colored bins on the bottom of the screen. Choose the correct bin at the bottom of the screen, or do not respond. It is possible that not responding is the correct response. If you go five seconds without responding, your answer will be recorded as ''no response''. If you wish to select one of the bins, use the ''1'' key to select the bin on the bottom left, use the ''2'' key to select the bin in the center, and use the ''3'' key to select the bin on the right. After a trial is over, at times you will receive feedback. At other times, you will not receive feedback, but there is always a correct response (or a correct ''no response''). Please contact the experimenter when you are finished or if you need to take a break. Do you have any questions?

On each trial, a randomly selected B stimulus was presented in the top center of the computer screen, and one of three differently colored squares (e.g., white, green, and red) appeared at the bottom left, center, and right of the computer screen. The location of the squares varied randomly over trials. Subjects selected a square by using the ''1'', ''2'', and ''3'' keys to select the left, center, or right square, respectively. Subjects also had the option of not responding. The task required subjects to select the ''correct'' square in the presence of each of the B stimuli.

Initial training trials with the B stimuli were presented in blocks of three trial types, one for each of the B stimuli. The correct color for the B stimuli varied across subjects. Training continued until subjects reached criterion over six consecutive trial blocks.

Once criterion with the B stimuli was reached, training was provided to establish different functions for the C and D stimuli in the CS task. Specifically, responding to the C stimuli as subjects had responded to the respective B stimuli was reinforced whereas responding to the D stimuli in any way other than a no response was punished. For example, if subjects were trained to select the green square in the presence of B1, then the selection of the green square in the presence of C1 was reinforced, but any key press in the presence of D1 was punished. That is, only a no response in the presence of the D stimuli was reinforced. Trials were presented in blocks of nine: one trial for each of the B, C, and D stimuli. Once criterion was met over two consecutive trial blocks, two blocks of the same trials were presented without feedback in order to ensure that performance would maintain without it.

Once criterion was met, a new CS task with the B stimuli was trained using three new colors. Once criterion was reached, new C and D test trials were presented with the new colors. Subjects who met criterion moved on to Step 4. Subjects who did not meet criterion after six trial blocks (54 trials) were presented with these same trial blocks with feedback until criterion was reached. Once the training criterion was reached, blocks of the same trials were given without feedback. Training and testing were repeated until criterion was met. This step was repeated with different colors until subjects met criterion on the first set of C and D test trials on a new CS task. A large array of colors was available for the color selection task so that no color was used more than once.

Step 4: Combined training of new LC and CS tasks and testing differential transfer of function with the C and D stimuli. At the beginning of Step 4, subjects were told that they would be presented with the same kind of tasks they had seen already, but LC and CS trials would be interspersed. LC and CS trials were interspersed randomly within the constraints described below. Initial training trials with the B stimuli were presented in blocks of six trial types: one LC and one CS trial for each of the B stimuli. Subjects were required to meet criterion over three consecutive training trial blocks. Test trials were then presented without feedback. Test trials were presented in blocks of 18 trials, including one LC and one CS trial for each of the B, C, and D stimuli. Meeting criterion over two consecutive trial blocks was required to move on to Step 5. Subjects who did not meet criterion after six consecutive blocks were given these same trial blocks with feedback until they reached criterion. These same trials were repeated without feedback until criterion was met over two consecutive test trial blocks. Iterations of retraining and retesting continued with new LC and CS tasks until subjects met criterion on the initial blocks of test trials.

Step 5: Training the position-selection (PS) task with the B stimuli, and punishing transfer of function and training "no response" to the C and D stimuli. The B stimuli were used to train the subjects in a PS task. The following instructions were presented:

> For this task, there will be a single stimulus in the middle of the screen, and four boxes at each of the corners of the screen. Inside each of these boxes will be a number. You may select one of the four locations on the screen, or do not respond. It is possible that not responding is the correct response. If you go five seconds without responding, your answer will be recorded as "no response". If you wish to select the correct location, press the key corresponding to the number that is inside the box at that correct location. After a trial is over, at times you will receive feedback. At other times, you will not receive feedback, but there is always a correct response (or a correct "no response"). Please contact the experimenter when you are finished, or if you need to take a break. Do you have any questions?

For the PS task, a randomly selected B stimulus was presented in the middle of the screen along with four boxes, one in each corner. The numbers 1 through 4 were randomly assigned and appeared inside the boxes. The task required subjects to select the number of the box that was in the "correct" position on the screen. For example, the experimenter-defined correct positions for B1, B2, and B3 could be the upper left corner, lower right corner, and upper right corner, respectively. Subjects selected the position by pressing the key corresponding to the number present in that position for that particular trial. Subjects also had the option of not responding. Initial training trials with the B stimuli were presented in blocks of three trial types, one for each of the B stimuli. Meeting criterion in six consecutive three-trial blocks allowed subjects to move on to training with the C and D stimuli.

Training was then provided to punish any responding to the C and D stimuli on the PS task other than a no response, which was reinforced. Trials were presented in blocks of nine, one for each of the B, C, and D stimuli. Once criterion was met over two consecutive trial blocks, the same trials were presented without feedback.

Once criterion was reached, subjects were trained on a new PS task with the B stimuli, with the correct position for each B stimulus quasirandomly reassigned. The only restriction was that the same location was not assigned to the same B stimulus for consecutive iterations. Once criterion was reached, subjects again moved to testing and were given up to six 9-trial test blocks without feedback to test for the absence of function transfer with the C and D stimuli. Subjects meeting the initial testing criterion moved on to Step 6. Subjects who did not meet criterion after six consecutive test trial blocks were given these same trial blocks with feedback until criterion was reached. Once it was reached, the directly trained trials were repeated without feedback. As in Steps 2 and 3, new iterations of retraining and retesting occurred until subjects met criterion on the initial test trials with a new PS task.

Step 6: Combined training on the LC, CS, and PS tasks with the B stimuli and testing differential transfer of function with the C and D stimuli. At the beginning of Step 6, subjects were told that they would receive intermixed series of trials consisting of all three previously learned tasks. They were then trained to perform new LC, CS, and PS tasks with the B stimuli. Test trials without feedback were then presented to test for the intended control by the topography of the C and D stimuli over function transfer. If the intended control was not evident, additional training trials were provided.

Within the following constraints all three task-trial types were interspersed randomly. Initial training trials with the B stimuli were presented in blocks of nine trial types: one LC, one CS, and one PS trial for each of the three B stimuli. Subjects were required to meet criterion in two consecutive trial blocks. Once criterion was reached, no feedback test trials were presented in 27-trial blocks composed of the nine directly trained B trials and 18 new test trials: one for each C and D stimulus for each of the three task types. Subjects meeting criterion over two consecutive trial blocks in initial testing were administered a final equivalence test like that in Step 1. They then advanced to Step 7. Subjects who did not meet criterion after four consecutive trial blocks were given the same trials with feedback until criterion was reached, followed by more trials without feedback. Training and testing were repeated until the test criterion was met. Then, Step 6 was repeated until subjects met criterion on the initial test for the differential transfer of functions in a pattern consistent with previous training. Finally, subjects were given an equivalence test like that in Step 1 before advancing to Step 7.

Step 7: Establishing three 4-member equivalence classes with new stimulus sets, training new LC, CS, and PS tasks with the B stimuli, and testing differential transfer of function with the C and D stimuli. Twelve new stimuli were used to establish three new four-member equivalence classes. The stimulus topographies (e.g., linear, circular, three-sided, and four-sided) that defined the alpha designations of the previous stimulus classes were maintained. The procedures for establishing the equivalence classes were identical to those in Step 1.

Procedures were used to determine whether control by stimulus topography over function transfer would generalize to a new set of equivalence classes. Following training and testing for the formation of the equivalence classes, subjects were trained to perform new CS, LC, and PS tasks with the B stimuli using the procedures described in Step 6. If the intended pattern of control was evident on the initial test trials, generalized contextual control by stimulus topography over function transfer was said to have been demonstrated, and subjects moved to a final equivalence test for the recently learned equivalence classes. If the intended control was not evident on the initial test trials, retraining and retesting occurred as described in Step 6. Following this, Step 7 was repeated with new stimulus sets a maximum of two times. Subjects moved on to a stimulus equivalence test after meeting criterion on the initial set of test trials or after the second iteration of function training with the LC, CS, and PS tasks, regardless of performance. For the final equivalence tests, testing procedures were identical to those in Step 1 with the appropriate stimulus set. The experiment terminated upon completion of this step, and subjects were debriefed.

RESULTS

All 5 subjects who returned after the first experimental session completed the experiment. The 9 subjects who did not return were introductory psychology students who received the maximum four credits for their experimental participation after the first session, and then chose to not continue beyond that point. This is not uncommon in our experience when using introductory psychology students as subjects in studies that take longer than 4 hr to complete. However, inspection of the data from those 9 subjects showed that their performance up to the point of termination was not obviously different from that of the 5 subjects who finished the experiment.

Data for the 5 subjects who completed the experiment are presented in Tables 1 and 2. Although stimulus presentations across the various steps of the experiment were organized in blocks of 3, 9, 18, 27, 36, or 54 trials, the data are reported in 18-trial blocks for ease of presentation and to facilitate comparison across experimental conditions. Numbers following the LC, CS, or PS designations refer to the iteration of the respective tasks within each step of the experiment. For example, LC2 would refer to the second iteration of the letter-choice task within that particular experimental step. Letter combinations, such as LC + CS, refer to trial blocks with different trial types interspersed (letter choice and color selection, for example). Tr (train) refers to trials followed by feedback, and Ts (test) refers to trials without feedback. A dash indicates an experimental substep that was skipped or was unnecessary. F designates failure to reach criterion, and an asterisk indicates a session break.

Inspection of Tables 1 and 2 reveals that all 5 subjects demonstrated generalized contextual control by stimulus topography over the transfer of functions. However, there was considerable variability across subjects in terms of the rate at which they moved through the various experimental steps. In Step 1, all 5 subjects met criterion on the tests for symmetry and equivalence, with no subjects requiring additional training in the baseline conditional discriminations.

In Step 2, the 5 subjects completed training on the first letter-choice selection task with the B stimuli (LC1 - B) in two to five 18-trial blocks. Next, 4 subjects (1, 3, 4, and 5) showed evidence of transfer of function when tested with the C and D stimuli on LC1 (LC1 - BCD). Subject 2 failed that test and received six additional nine-trial blocks of LC1 - BCD training (54 trials) and two nine-trial blocks (18 trials) before meeting test criterion. After

Table 1
Number of 18-trial blocks to criterion by subject: steps 1 through 6.

Step	Task	Subject 1	2	3	4	5
1	Tr Cond Discr: Stim Set 1	7	10	9	13	10
	Ts Equiv Classes: Stim Set 1	3	3	3	3	3
2	Tr LC1 - B	4	3	5	2	3
	Ts LC1 - BCD	1	3F	1	2	1
	Tr LC1 - BCD	-	3	-	-	-
	Ts LC1 - BCD	-	1	-	-	-
	Tr LC2 - B	-	3	-	-	-
	Ts LC2 - BCD	-	1	-	-	-
3	Tr CS1 - B	3	2	2	3	2
	Tr CS1 - BCD	7	10	6	6	10
	Ts CS1 - BCD	1	1	1	1	1
	Tr CS2 - B	3	3	2	2	3
	Ts CS2 - BCD	3F	3F	3F	3F	3F
	Tr CS2 - BCD	2	2	1	2	2
	Ts CS2 - BCD	1	1	1	1	1
	Tr CS3 - B	2	3	2	3	4
	Ts CS3 - BCD	1	1	3F	1	3F
	Tr CS3 - BCD	-	-	1	-	2
	Ts CS3 - BCD	-	-	1	-	1
	Tr CS4 - B	-	-	2	-	2
	Ts CS4 - BCD	-	-	1	-	2
4	Tr LC1 + CS1 - B	2	4	3	4	5
	Ts LC1 + CS1 - BCD	6	6F	6F	6F	6F
	Tr LC1 + CS1 - BCD	-	2	3	3	3
	Ts LC1 + CS1 - BCD	-	2	2	2	2
	Tr LC2 + CS2 - B	-	6	3	7	9
	Ts LC2 + CS2 - BCD	-	2	2	2	2
5	Tr PS1 - B	2	3	2	3	2
	Tr PS1 - BCD	3	2	2	4	2
	Ts PS1 - BCD	1	1	1	1	1
	Tr PS2 - B	2	2	2	2	2
	Ts PS2 - BCD	1	1	1	1	1
6	Tr LC1 + CS1 + PS1 - B	4	5	3	5	5
	Ts LC1 + CS1 + PS1 - BCD	6F*	3	3	3	3
	Tr LC2 + CS2 + PS2 - B	4	-	-	-	-
	Ts LC2 + CS2 + PS2 - BCD	6F	-	-	-	-
	Tr LC2 + CS2 + PS2 - B	5	-	-	-	-
	Ts LC2 + CS2 + PS2 - BCD	3	-	-	-	-
	Tr LC3 + CS3 + PS3 - B	3	-	-	-	-
	Ts LC3 + CS3 + PS3 - BCD	3	-	-	-	-
	Ts Equiv Classes: Stim Set 1	3	3*	3	3*	3

Note. Data are presented with description of task and stimuli used. For example, LC1 - BCD refers to trial blocks of the letter-choice task with presentation of B, C, and D stimuli interspersed within the trial blocks. Tasks between steps and between subjects were different. For example, the stimuli used and responses required in LC1 were different from the stimuli used and the responses required in LC2 for Subject 1. Also, the stimuli and responses in LC1 for Subject 1 were different from the stimuli and responses in LC1 for Subject 2. For the sake of brevity, task numbers start over again for each stimulus set. A dash (-) indicates a step that was skipped or was not necessary. Tr = training; Ts = testing; Cond Discr = conditional discriminations; Equiv = equivalence; F = fail; Stim = stimulus; LC = letter-choice task; CS = color-selection task; PS = position-selection task; * = session break.

training on a new LC task (LC2), Subject 2 responded in line with function transfer on the first set of LC2 - BCD trials.

In Step 3, all 5 subjects met training criterion on the first CS - B task after two (Subjects 2, 3, and 5) or three (Subjects 1 and 4) blocks of trials. Subjects then required 7, 10, 6, 6, and 10 blocks of trials, respectively, to meet criterion on the BCD training on CS1 (CS1 - BCD). All met criterion on the subsequent block of CS1 - BCD test trials. Returning to training, subjects required two (Subjects 3 and 4) or three (Subjects 1, 2, and 5) blocks of training trials to meet criterion on CS2 - B, and then all 5

Table 2

Number of 18-trial blocks to criterion by subject: step 7.

		Subject				
Step	Task	1	2	3	4	5
7	Tr Cond Discr: Stim Set 2	7	7	6	8	9
	Ts Equiv Classes: Stim Set 2	3	3	3	3	3
	Tr LC1 + CS1 + PS1 - B	6	9	12	14	14*
	Ts LC1 + CS1 + PS1 - BCD	3	6F	6F	3	-
	Tr LC1 + CS1 + PS1 - BCD	-	6	10*	-	-
	Ts LC1 + CS1 + PS1 - BCD	-	3*	-	-	-
	Ts Equiv: Stim Set 2	3	3	3	3	3
	Tr LC2 + CS2 + PS2 - B	-	4	4	-	6
	Ts LC2 + CS2 + PS2 - BCD	-	3	6F	-	6F
	Tr LC2 + CS2 + PS2 - BCD	-	-	4	-	3
	Ts LC2 + CS2 + PS2 - BCD	-	-	3	-	3
	Tr LC3 + CS3 + PS3 - B	-	-	3	-	6
	Ts LC3 + CS3 + PS3 - BCD	-	-	3	-	3
	Ts Equiv Classes: Stim Set 2	-	3	3	-	3
	Tr Cond Discr: Stim Set 3	-	8	6	-	4
	Ts Equiv Classes: Stim Set 3	-	3	3	-	3
	Tr LC1 + CS1 + PS1 - B	-	3	11	-	5
	Ts LC1 + CS1 + PS1 - BCD	-	3	6F	-	3
	Tr LC1 + CS1 + PS1 - BCD	-	-	11*	-	-
	Ts Equiv Classes: Stim Set 3	-	3	3	-	3
	Tr LC2 + CS2 + PS2 - B	-	-	8	-	-
	Ts LC2 + CS2 + PS2 - BCD	-	-	6F	-	-
	Tr LC2 + CS2 + PS2 - BCD	-	-	7	-	-
	Ts LC2 + CS2 + PS2 - BCD	-	-	3	-	-
	Tr LC3 + CS3 + PS3 - B	-	-	4	-	-
	Ts LC3 + CS3 + PS3 - BCD	-	-	3	-	-
	Ts Equiv Classes: Stim Set 3	-	-	3*	-	-
	Tr Cond Discr: Stim Set 4	-	-	7	-	-
	Ts Equiv Classes: Stim Set 4	-	-	3	-	-
	Tr LC1 + CS1 + PS1 - B	-	-	3	-	-
	Ts LC1 + CS1 + PS1 - B	-	-	3	-	-
	Ts Equiv Classes: Stim Set 4	-	-	3	-	-

Note. Tr = training; Ts = testing; Cond Discr = conditional discriminations; Equiv = equivalence; F = fail; Stim = stimulus; LC = letter-choice task; CS = color-selection task; PS = position-selection task; * = session break.

subjects failed the subsequent test of control by stimulus topography over transfer of function. On those tests, all 5 subjects responded to all of the C and D stimuli as they had been trained to respond to the respective B stimuli. Except for Subject 3, who required only one block of trials, subjects required two additional blocks of CS2 - BCD training trials. All 5 subjects then passed the subsequent CS2 - BCD tests. Returning to training, Subjects 1 and 3 required two blocks, Subjects 2 and 4 required three blocks, and Subject 5 required four blocks of training trials to meet criterion on CS3 - B. Subjects 1, 2, and 4 then met criterion on the first block of CS3 - BCD test trials and moved on to Step 4. Subjects 3 and 5 failed the tests and received, respectively, one and two additional blocks of CS3 - BCD training trials before passing the subsequent CS3 - BCD test. These subjects returned to training and required two blocks of CS4 - B training trials before passing the subsequent CS4 - BCD test after one and two blocks of trials, respectively.

Step 4 began with the combined training of new LC and CS tasks with the B stimuli (LC1 + CS1 - B) followed by blocks of LC1 + CS1 - BCD test trials. Only Subject 1 met test criterion. The remaining subjects required two (Subject 2) or three (Subjects 3, 4, and 5) additional blocks of LC1 + CS1 - BCD training trials before meeting criterion on the subsequent test trials. Subjects 2 to 5 then required 6, 3, 7, and 9 blocks of training trials, respectively, to meet criterion on the LC2 + CS2 - B training trials. All then met criterion on the subsequent LC2 + CS2 - BCD test trials.

In Step 5, all subjects met the PS1 - B training criterion within three blocks of trials and then met criterion on the PS1 - BCD training and test trials. Following this, all subjects quickly met the PS2 - B training criterion and PS2 - BCD test criterion to complete Step 5.

In Step 6, which consisted of combined LC + CS + PS - B trials, all subjects met training criterion within five blocks of trials. Subjects 2, 3, 4, and 5 then met the test criterion on the ensuing LC1 + CS1 + PS1 - BCD test trials, thereby demonstrating contextual control by stimulus topography over transfer of function. Subject 1 failed the initial test and then terminated the session. The next session started with a new iteration of LC + CS + PS - B tasks. Subject 1 required two new iterations before meeting criterion on LC3 + CS3 + PS3 - BCD test trials. All subjects met criterion on a test of equivalence relations at the end of Step 6.

In Step 7 (Table 2), all 5 subjects met criterion on the tests for symmetry and equivalence with Stimulus Set 2. No subject required additional training on the baseline conditional discriminations. Following this, subjects required, respectively, 6, 9, 12, 14, and 14 blocks of LC1 + CS1 + PS1 - B training trials (numbering starts with one for the new stimulus set) to reach criterion. Then, Subjects 1 and 4 met LC1 + CS1 + PS1 - BCD test criterion after the third block of trials. This was the first demonstration of generalized contextual control by stimulus topography over transfer of function. These 2 subjects then met criterion on the final equivalence test and were debriefed and dismissed from the study.

Subject 5 terminated the session before the first LC1 + CS1 + PS1 - BCD test trials were administered. Subjects 2 and 3, respectively, required 6 and 10 blocks of additional LC1 + CS1 + PS1 - B training trials before meeting criterion, and Subject 2 then passed the subsequent LC1 + CS1 + PS1 - BCD test trials before taking a session break. Subject 3 required a session break before completing those test trials. Upon returning to the experiment, all 3 subjects passed an equivalence test and were presented with LC2 + CS2 + PS2 - B training trials.

Subjects 2, 3, and 5 required, respectively, four, four and six blocks of LC2 + CS2 + PS2 - B training trials to meet criterion, and only Subject 2 met criterion on the subsequent LC2 + CS2 + PS2 - BCD test trials. Subject 2 was then administered the final equivalence test with stimulus set 2, which she passed. Subjects 3 and 5 required, respectively, four and three blocks of LC2 + CS2 + PS2 - BCD training trials before meeting criterion on the subsequent set of test trials. These 2 subjects were then given three and six blocks of LC3 + CS3 + PS3 - B training trials, respectively, before meeting criterion on the subsequent LC3 + CS3 + PS3 - BCD test trials. Subjects 3 and 5 then met criterion on the final equivalence test with Stimulus Set 2.

After meeting the equivalence test criterion with Stimulus Set 3, Subjects 2 and 5 required, respectively, three and five blocks of LC1 + CS1 + PS1 - B training trials to meet criterion. Both then passed the subsequent LC1 + CS1 + PS1 - BCD test trials, demonstrating generalized control by stimulus topography over transfer of function. They then met criterion on the final equivalence test with Stimulus Set 3 and were debriefed and dismissed from the study. Subject 3 required 11 blocks of LC1 + CS1 + PS1 – B training trials to meet criterion. However, this subject failed to meet the LC1 + CS1 + PS1 - BCD testing criterion and completed 11 blocks of LC1 + CS1 + PS1 - BCD training trials before taking a session break. Upon return, Subject 3 was administered an equivalence test for Stimulus Set 3. She then required eight blocks of LC2 + CS2 + PS2 – B training trials to meet criterion, but then failed the subsequent LC2 + CS2 + PS2 - BCD tests. This subject eventually met testing criterion on LC3 + CS3 + PS3 - BCD trials, and then passed the final equivalence test with Stimulus Set 3 before terminating the session.

Upon returning to the experiment, Subject 3 met criterion for equivalence with Stimulus Set 4. She then required three blocks of LC1 + CS1 + PS1 - B training trials to meet criterion and passed the LC1 + CS1 + PS1 - BCD test trials in three blocks of trials. She then passed the final equivalence test with Stimulus Set 4. At that point, she was debriefed and dismissed from the study.

DISCUSSION

All 5 subjects who completed the experiment demonstrated generalized contextual control over derived transfer of functions. Using multiple exemplar training, the forms of the stimuli acquired differential control over specific discriminative functions acquired indirectly or via transfer of function. As described previously, this study extended the results of the Dougher et al. (2002) study in two ways: 1) Control over transfer of function was established by the topographical features of the equivalence class members themselves, rather than by separate, external stimuli; 2) Subjects were allowed to refrain from responding or to not emit experimenter-defined responses in contexts where function transfer was punished. Both of these differences were thought to be more analogous to natural settings where contextual control over transfer of function by stimulus topography is common and where not responding in such contexts is appropriate and typical.

In the current study, multiple exemplar training procedures (Barnes, Healy, & Hayes, 2000; Fields & Reeve, 2000; Lea & Ryan, 1990) were used to establish generalized contextual control of transfer of function. More specifically, subjects were provided with many trials in which behaving in accord with function transfer was differentially reinforced or punished depending on the presence of a class of physical features of the stimuli. Across trials, subjects were required to abstract the stimulus features that were differentially associated with reinforcement or punishment for behaving in line with function transfer. Although some subjects required large numbers of trials, transfer of function eventually came under the intended stimulus control for all subjects.

Interestingly, on the early trials of every task (i.e., before the differential reinforcement and punishment procedures took effect), every subject demonstrated transfer of function. That is, all subjects responded to each member of the equivalence classes as they had been trained to respond to the B stimuli of the classes. Each did so until such responding produced differential consequences. This pattern of responding was similar to that reported by Dougher et al. (2002) and again demonstrated that transfer of function is a robust phenomenon and is likely to occur in the absence of a training history that establishes its contextual control. In this case, the differential reinforcement and punishment procedures led subjects either to behave in line with function transfer or simply to refrain from emitting any keyboard responses in the presence of specific stimulus features on specific tasks.

The behavior of the participants on the early trials of the experimental tasks is also similar to the lack of appropriate stimulus control exhibited by the children in the studies described earlier (DeLoache, 2004; DeLoache, Pierroutsakos, & Uttal, 2003; DeLoache, Uttal & Rosengren, 2004). Recall that the children in those studies tried to put their mouths on the picture of a bottle and interacted with miniature, toy chairs and cars as they did with real chairs and cars. In accounting for this behavior, DeLoache claimed, ''They (the children) just don't have experience with pictures. They are confusing a symbol, which is a picture, with the referent'' (quoted in Bloomekatz, 2005, p. 19). In these examples, the picture of the bottle and the toy cars were physically similar to their ''referent,'' so simple stimulus generalization would explain the lack of appropriate stimulus control. However, the confusion of symbol and referent is precisely relevant to stimulus equivalence and the transfer of function. The critical difference between stimulus generalization and transfer of function is that, in the latter, functions are acquired by stimuli that are physically dissimilar and arbitrarily related, as are words and their referents. It is not clear at this point, of course, what types of experience DeLoache was referring to or what experiences are necessary in natural settings to establish appropriate stimulus control. However, the present results along with those of Dougher et al. (2002) demonstrate that multiple-exemplar training is sufficient to do so in laboratory settings.

As stated earlier, the present study is a simple experimental analogue demonstrating how generalized stimulus control over function transfer might arise in natural settings. The three differently shaped types of stimuli in the equivalence classes might be considered analogous to natural equivalence classes consisting of an object, the spoken word for the object, and the written word for the object. All three members of the class can evoke common perceptual and verbal responses. However, certain responses occur in the presence of the object and not in the presence of the spoken or written word. Also, certain responses occur in the presence of the object and the written word and not in the presence of the spoken word. This differential stimulus control over the functions evoked by the members of an equivalence class is necessary for appropriate functioning in natural settings, or else we would find ourselves driving on maps, swatting the printed names of flying insects, and running from rooms when someone utters the word *snake*. Of course, the members of naturally existing stimulus classes differ from each other in many more ways then do the visual forms used in our study. In addition, the contingencies that produce contextual control in natural settings are different from the social contingencies used in our study. However, the behavioral processes may be quite similar.

Many examples can be generated showing how inappropriate function transfer could be punished in natural settings. However, reinforcement of not transferring may occur as well. When parents tell their children that ''sticks and stones may break your bones but words won't,'' they are emphasizing that certain contingencies that operate in the physical world do not apply to language. If a child tells an imaginary story about fighting a wild dog, that child may be praised by a parent for not transferring that behavior to real dogs.

One obvious limitation with the present study and with all studies that use adult humans to investigate basic behavioral processes is that adults have rich and complex verbal repertoires that interact with laboratory procedures. Based upon postexperimental discussions with our participants in this and other studies, it is apparent that they verbalize almost continuously during the experiments and that they often rely on their verbal repertoires to figure out how they are supposed to behave on the experimental tasks. This does not negate the value of the data obtained in laboratory studies with adults, but it does highlight the need for a greater understanding of complex verbal repertoires. Sidman (1986) has emphasized the explication of contextual control as the key to understanding complex human behavior such as language and the determination of meaning. What we have shown in the present study is that multiple exemplar training is sufficient to produce generalized contextual control by stimulus topography over transfer of function in adult humans. Multiple exemplar training and its inherent differential reinforcement procedures seems to be a plausible process by which contextual control over transfer of function may emerge in natural settings, but establishing the ecological validity of these procedures is an important next step in understanding the contextual control of meaning.

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